Modified dihadron fragmentation functions in hot and nuclear matter.

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Medium modification of the jet structure has emerged as a new diagnostic tool for the study of substructure of dense matter. The modification goes beyond a mere suppression of inclusive spectra of leading hadrons and can be extended to include the modification of many particle observables [1–3], the simplest of which are two-hadron correlations within the jet cone. Such two-hadron correlations have been measured both in DIS and high-energy heavy-ion collisions. Theoretically, these are studied as the medium modification of the dihadron fragmentation functions.

The calculation of the modified dihadron fragmentation function at the next-to-leading twist in a nucleus includes contributions from three separate types of processes. The struck quark may lose energy by radiating a gluon prior to escaping the medium and then fragmenting, and both detected hadrons originate in this fragmentation. The radiated gluon may escape the medium and both hadrons may originate in the fragmentation of the gluon. Both the struck quark and the radiated gluon may escape the medium and one of the hadrons originates form the quark and the other from the gluon.

With no additional parameters, one can predict the nuclear modification of dihadron fragmentation functions within the same kinematics. It is more illustrative to study the modification of the conditional distribution for the associated second rank hadrons, *i.e.*, the ratio of the dihadron to the single hadron fragmentation function of the leading hadron. Shown in Fig. 1 is the predicted ratio of the associated hadron distribution in DIS off a nitrogen ($A = 14$) target to that off a proton ($A = 1$), as compared to the HERMES experimental data.

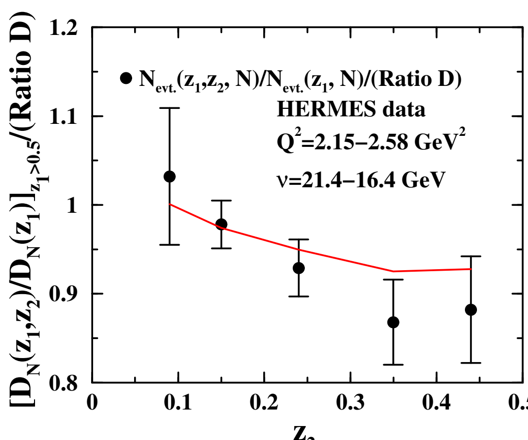

FIG. 1: Results of the medium modification of the associated hadron distribution in a cold nuclear medium versus its momentum fraction. The momentum fraction of the leading hadron z_1 is integrated over all allowed values above 0.5.

In high-energy heavy-ion (or $p+p$ and $p+A$) collisions, jets are always produced in back-to-back pairs. Correlations of two high-p_T hadrons in azimuthal angle generally have two Gaussian peaks. Relative to the triggered hadron, same-side hadrons come from the fragmentation of the same jet and therefore are related to dihadron fragmentation functions.

The change of the near-side correlation due to the modification of dihadron fragmentation functions in heavy-ion collisions can be similarly calculated. For a given value of $p_T^{\rm trig}$ of the triggered hadron, one can calculate the average initial jet energy $\langle E_T \rangle$. Because of trigger bias and parton energy loss, $\langle E_T \rangle$ in heavy-ion collisions is generally larger than that in $p+p$ collisions for a fixed $p_T^{\rm trig}$ The ratio of such associated hadron distributions in $Au+Au$ versus $p+p$ collisions, referred to as I_{AA}, is plotted as the solid line in the right hand plot of Fig. 2 together with the STAR and PHENIX data. In central $Au+Au$ collisions, triggering on a high p_T hadron biases toward a larger initial jet energy and therefore smaller z_1 and z_2. This leads to an enhancement in I_{AA} due to the shape of dihadron fragmentation functions. The enhancement increases with N_{part} because of increased gluon density and system size which leads to an increased total energy loss. For more peripheral collisions for a small enough trigger p_T, the Cronin effect has an opposite influence to that of energy loss, resulting in the I_{AA} falling below unity. This affect disappears at higher trigger p_T.

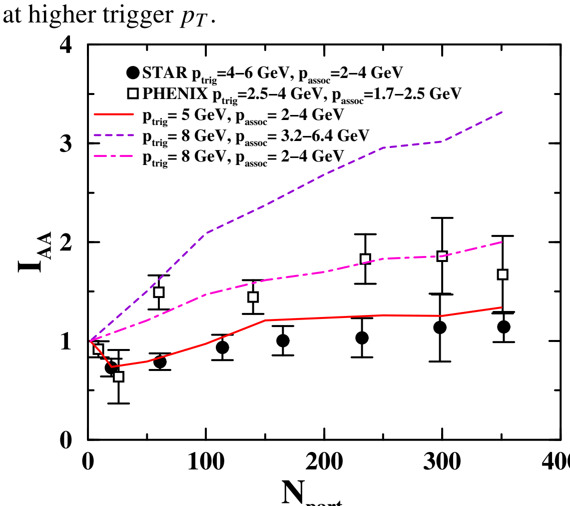

FIG. 2: Calculated medium modification of associated hadron distribution from jet fragmentation in $Au+Au$ collisions at $\sqrt{s} = 200$ GeV for different choices of trigger p_T and associated p_T as compared to experimental data

[1] A. Majumder, E. Wang, and X.-N. Wang (2004), nucl-th/0412061.
[2] A. Majumder (2005), nucl-th/0503019.
[3] A. Majumder (2005), nucl-th/0501029.